REMARKS

By the foregoing amendments claim 36 has been amended, claims 1-35 and 37-48 have been cancelled and new claims 49-95 have been added. Thus, claims 36 and 49-95 are in the application.

Applicants gratefully acknowledge the courtesy telephone interview granted to their undersigned attorney by Examiner Michael Band on December 6, 2007. During the interview the undersigned discussed the present invention and compared and contrasted the present invention with the patent to Wang U.S. 6,352,629 (Wang No. 1), Wang U.S. 2004/0020768 (Wang No. 2) and Chiang US 6,398,929. Differences between the present invention and the prior art were noted as discussed below and as recited in the claims as amended. The remarks presented during the telephone interview are summarized below in support of the patentability of the claims as amended.

Claims 1-35, 42, and 44-48 were rejected in the Office Action under 35 U.S.C. §112, second paragraph, as being indefinite for the reasons stated on pages 2 and 3 of the Office Action. While this rejection has been rendered moot in view of the cancellation of the rejected claims, it is respectfully submitted that the new claims in the application properly reference a magnetic field or magnetic field pattern rather than the generic "field" as referred to in the rejection.

Claims 1-3, 6-17, 19-22, 25-28 and 45-48 were rejected in the outstanding Office Action under 35 U.S.C. §102(b) as being anticipated by Wang, U.S. 6,352,629 (Wang No. 1) as stated on pages 3-8 of the Office Action. Claims 29-33 and 35-41 were rejected under 35 U.S.C. §102(b) as

being anticipated by Chiang, U.S. 6,398,929 as stated on pages 8-12 of the Office Action. Claim 34 stands rejected under 35 U.S.C. §102(b) as being anticipated or, in the alternative, under 35 U.S.C. §103(a) as obvious over Chiang et al. U.S. 6,398,929 as stated on pages 12 and 13 of the Office Action. Claims 4, 5 and 44 were rejected in the Office Action under 35 U.S.C. §103(a) as being unpatentable over Wang U.S. 6,352,629 (Wang No.1) as applied to claim 1 and further in view of Chiang, et al. U.S. 6,398,929. The references were combined as stated on pages 13 to 15 of the Office Action. Claim 18 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Wang U.S. 6,352,629 (Wang No. 1) as indicated on page 15 of the Office Action. Claims 23, 24, 42 and 43 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Wang, U.S. 6,352,629 (Wang No. 1) as applied to claim 22, and further in view of Chiang et al. U.S. PGPub 2001/0050220 as stated on pages 15-17 of the Office Action. These rejections are hereby traversed and reconsideration thereof is respectfully requested in view of the above amendments to the claims and Applicants' remarks set forth during the aforementioned telephone interview as summarized below.

An important difference between the present invention and each of the applied references to Wang, U.S. 6,352,629 (Wang No. 1) and Chiang, U.S. 6,398,929 and Chiang, et al. U.S. PG Pub 2001/0050220, is made clear by considering the meaning of an unbalanced long-range magnetic field pattern which is symmetric as compared to an unbalanced long-range magnetic field pattern which is non-symmetric, i.e. asymmetric. By way of explanation, during the telephone interview the undersigned referred to Wang et al. U.S.

2004/0020768 (Wang No. 2) wherein an unbalanced long-range magnetic field pattern is described with respect to its symmetry and asymmetry criteria.

Wang No. 1, i.e., U.S. 6,352,629, addresses (column 3, line 38) some drawbacks of long-throw sputtering relying upon an unbalanced magnetron to project the magnetic field toward the wafer. Such an unbalanced magnetron magnetic field pattern is also described in Applicants' specification, see pages 2-6 of the specification under the heading "2. Magnetron magnetic field with unbalanced component pattern" and Figure 1 of the application drawings. Applicants respectfully submit that the unbalanced magnetron magnetic field as addressed in Wang No. 1 applied against Applicants' claims is symmetrical. Applicants note that at the time of the invention of Wang No. 1, such field being asymmetric was not contemplated. It is only in Wang No. 2 that such unbalanced magnetron magnetic field being asymmetric (non-symmetric [0026]) is addressed.

Wang No. 2 addresses in the context of its Figure 1, [0023], first a circularly symmetric outer sidewall magnet ring 32 resulting in magnetic field components 48 which is a symmetric unbalanced magnetron magnetic field pattern according to Applicants' description. Wang No. 2 further addresses [0025] that with a symmetric magnetic focusing illustrated in Figure 1 of Wang No. 2, at the center of the wafer 24 metal ions dominate the hole filling to produce the structure of Figure 2, but at the periphery of the wafer 24 metal neutrals dominate in the hole filling.

Wang No. 1 which is referred to in the Office Action rejections, in Figure 1 and column 4, lines 54-56 therein, teaches that the unbalanced magnetron (at 36) has outer poles 42 with a total magnetic flux integrated

over its area that is larger than that produced by inner pole 40. Thus, Wang No. 1 teaches an unbalanced magnetron magnetic field which is produced by the magnetic poles 42 being stronger than the magnetic pole 40. Not addressing that the outer poles 42 are of varying strength along their loop reveals that the unbalanced field is symmetric with respect to a center axis through magnet 40. It is further taught in Wang No. 1 to apply an axial magnetic field by means of coil 40. Even when rotating the arrangement 36 which generated an unbalanced symmetric magnetron magnetic field pattern within a substantially homogeneous axial magnetic field 30 as generated by the coil arrangement 40, an asymmetric unbalanced magnetron magnetic field pattern as is addressed in Applicants' specification and which is also clearly addressed in Wang No. 2 will not result.

Thus, Applicants respectfully disagree with the statement on page 4 of the Office Action that the unbalanced magnetron magnetic field pattern as of Wang No. 1 is asymmetric. This unbalanced magnetron magnetic field pattern as addressed by Wang No. 1 is symmetric. Please see the accurate addressing of Wang No. 1 on page 4, second paragraph of Applicants' specification. Since Wang No. 1 does not address the unbalanced magnetron magnetic field pattern to be asymmetric, the patent does not anticipate Applicants' invention as recited in the rejected claims under 35 U.S.C. §102.

On the other hand, as discussed during the telephone interview, Wang No. 2, after discussing with the help of Figure 1 therein wherein a circularly symmetric outer sidewall magnet ring 32 is used to generate a symmetric unbalanced magnetron magnetic field pattern, discusses [0026] using the outer sidewall magnet ring 32 to be non-symmetric about the central axis 14,

according to Figures 4, 5 and 6 having strong magnets 134 and 132 only applied along a part of the looping magnet arrangement 130. With reference to Figure 1 of Wang No. 2, this approach may be said to remove e.g. the left-hand magnets 32, maintaining the right-hand magnets 32 and thereby only maintaining a magnetic field pattern 48 at the right-hand side, making such pattern clearly asymmetric with respect to the loop axis 14. Applicants' invention includes at least two primary differences when considered in relation to Wang No. 2, that is, first, differences of generating the unbalanced asymmetric long-range magnetic field pattern, and, second, as to target conception. The application claims as amended includes specifics with respect to these different aspects by respective independent claims as discussed below and as referred to in the aforementioned telephone interview.

Considering the different generation of the asymmetric unbalanced long-range magnetic field pattern in accordance with the present invention as compared with Wang No. 2, Applicants note that as may clearly be seen from Wang No. 2 e.g. in Figures 4, 5 and 6, and also in Figure 7, there is generated the addressed long-range magnetic field pattern by an arrangement of magnets 132, 134 along a looping area (see Figure 6) and asymmetry is reached in that these strong magnets 132, 134 are provided only along a part of the addressed loop. In the area of 150 of Figure 6 or Figure 5, which accords with the left-hand arrangement of 130 in Figure 4 and in Figure 7, the asymmetry of the addressed magnetic field pattern is reached by establishing along that section of the loop no long-range magnetic field pattern at all. Thus, in Wang No. 2 the asymmetric unbalanced long-range magnetic field

pattern is realized by applying strong magnets along the predominate part of a looping area and providing no such strong magnets along the remainder of the addressed looping area.

In contrast thereto and in accordance with the present invention as illustrated in the example embodiment of Figure 2 of Applicants' specification, there is generated first a symmetric unbalanced long-range magnetic field pattern as by the magnetic arrangement 7a which forms a loop around A_L. The magnets 7a and the central magnet 5 form in fact an unbalanced symmetrical magnetic field pattern as is addressed with respect to Figure 1, arrangement 36 in Wang No. 1. According to the present invention this unbalanced symmetric long-range magnetic field pattern as generated by the magnet arrangement loop 7a is locally disturbed by locally superposing to the primarily symmetric unbalanced magnetic field pattern a de-symmetrising magnetic field which is generated, still according to Figure 2 of Applicants' specification, by the locally applied magnets 7b. This approach according to the present invention has significant advantages over an approach according to Wang No. 2.

A first significant advantage of the invention as compared with Wang No. 2 concerns the economy in the use of magnets for generating the tunnel-shaped magnetron magnetic field and the asymmetric unbalanced long-range magnetic field pattern. That is, because the magnetron field pattern, that is the tunnel-shaped magnetic field loop according to F_m of Figure 2 of the present application, is to be tailored to form a loop with homogeneously distributed magnetic field strength between magnet arrangement 5 and magnet arrangement 7a, providing according to the present invention an

unbalanced symmetrical long-range magnetic field pattern, it is possible to exploit the outer magnet arrangement loop for generating the magnetron magnetic field as of F_m also for generating a significant part of the long-range magnetic field. In contrast, in Wang No. 2 there is provided on one hand a magnet arrangement which generates the magnetron magnetic field as of the arrangement 116, 36 and 38 in Figure 4 and on the other hand a completely separate magnet arrangement as of 122, 124, 132 and 134 for generating directly the asymmetric unbalanced long-range magnetic field pattern. Thus, by generating first the unbalanced magnetic field pattern to be symmetric according to the present invention, the same loop of magnets which generate such symmetric long-range field may be exploited as magnet loop for generating the tunnel-shaped magnetron magnetic field too.

Secondly, the present invention generating first a symmetric unbalanced field and disturbing the symmetry thereof by a locally applied de-symmetrising field allows to maintain the advantages of such unbalanced symmetric long-range field always and all over the surface of the substrate only locally modulating this long-range field. With reference to Figure 2 of the application drawings, it may be seen that a strong long-range magnetic field is maintained all over the substrate surface. This is contrasted with the arrangement in Wang No. 2 wherein a strong, long-range magnetic field as of Figure 4 will only be maintained, momentarily, substantially along the left-hand part of substrate 24.

The third significant advantage of the present invention is that applying locally a de-symmetrising magnetic field may be said to provide a strong signal of the strong magnetic field as of the unbalanced symmetric field

pattern which is modulated by a control signal as by the de-symmetrising magnetic field. Following this concept, in fact the de-symmetrising magnetic field may be considered as a modulating magnetic field, which may be selected substantially weaker than the controlled magnetic field, namely the symmetric one, which approach opens the possibility to generate the asymmetric unbalanced magnetic field pattern controllably as by generating the de-symmetrising magnetic field by means of an electromagnet arrangement. In view of this and the aforementioned other significant advantages of the invention as compared with Wang No. 2, it is respectfully submitted that the present invention is inventive under 35 U.S.C. §102 and 103.

The second primary difference between the present invention and Wang No. 2 as noted above relates to target conception. Applicants note that it is most evident that Wang No. 2, see Figure 2, necessitates a highly complex, vault shaped target structure. In contrast, according to the present invention as illustrated in the example embodiment of Figure 3 of the application drawings, a substantially planar target arrangement is used. The substantially planar target arrangement significantly simplifies the overall construction, making use of a substantially planar plate-like target arrangement also opens the possibility to combine the magnetron with the magnet arrangement which establishes the long-range asymmetric unbalanced magnetic field. With reference to Figure 4 of Wang No. 2, in spite of the fact that the outer magnet loop 38 of the magnetron arrangement is much stronger than the more central pole 36 (see at the end of [0021]) and thus produces a symmetric unbalanced magnetic field, this unbalanced

symmetric magnetic field does practically not contribute to the long-range magnetic field adjacent to the surface of the substrate 24, because, as shown in Figure 4, the magnetic field emanating from the magnetic poles 38 will be closed on one hand to the pole 36 and on the other hand to the poles of magnets 132. Consequently, Wang No. 2 addresses that [0022] the roof magnetron 34 produces a semi-toroidal magnetic field 40, which is a magnetron magnetic field which is very strong and creates a very high plasma density in that portion of the roof 20 but does apparently not contribute to the long-range field.

In opposition thereto, according to the present invention under this aspect a substantially plate-shaped target arrangement permits using the magnetron to generate the magnetron magnetic field as well as a significant part of the long-range magnetic field, namely the symmetrical unbalanced long-range magnetic field, which latter is locally modulated to become an asymmetric unbalanced long-range magnetic field.

Chiang U.S. 6,398,929 also fails to anticipate, 35 U.S.C. § 102 or render obvious, 35 U.S.C. §103, Applicants' claimed invention. From the above explanation of the difference between a symmetric unbalanced magnetron magnetic field and an asymmetric unbalanced magnetron magnetic field, it is evident that even if the south pole magnet arrangement in Figure 4 of Chiang is much stronger than the inner pole, the north pole, the resulting magnetron magnetic field is unbalanced, but is symmetrically unbalanced. Thus, the reference is no more relevant than Wang No. 1 and clearly less relevant than Wang No. 2. Chiang, et al. U.S. 2001/0050220 relied upon as a secondary reference in combination of Wang No. 1 in the

rejection of claims 23, 24, 42 and 43, does not provide for the aforementioned deficiencies of Wang No. 1.

In view of the above amendments and remarks, it is believed that the claims as amended patentably define over the cited references. However, if the Examiner finds that outstanding issues remain in the application, he is invited to telephone the undersigned with a view toward resolution of such matters in order to place the application in condition for allowance.

A Petition for Extension of Time is filed herewith to permit the timely filing of this Amendment.

Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 01-2135 (Case No. 635.43483X00) and please credit any excess fees to such deposit account.

Respectfully submitted,

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Attachments